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of gravity. How enormously complex must be the judgment-problems here involved, is apparent when we consider that each difference of position involves changes in some elements of the complex psychosis of balance.

I present this simple fact to the active workers in the field of experimental psychology, hoping that it may prove of service to those who are engaged in the study of these special phenomena.

HENRY RUTGERS MARSHALL.

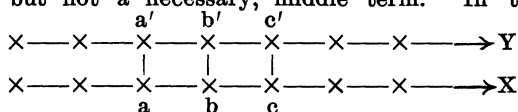
Zur Physiologie und Pathologie der Handschrift. GOLDSCHNEIDER.
Archiv für Psychiatrie, XXIV, 1892, 503.

An important contribution to the theory of hand-movements. G. gives, first, a theoretical account of the origin of what the present writer has called "tracery-imitation," under the equivalent phrase, *malende reproduction*, i. e., the association between visual pictures (letters, figures, etc.) and the hand-movements necessary to reproduce them (writing, drawing, etc.). He finds three "moments" in the rise of "tracery-imitation" (see his *résumé*, p. 587): A, an optical picture of the hand-movements (*optische Vorstellung der Handbewegung*) required for making the desired letter, derived from the child's earlier sight of his own hand-movements; B, a series of new motor discharges, strengthened by practice; C, a series of sensations of actual movement, by which the discharges are regulated and controlled. Moment A is clearly seen in the fact, often remarked, that in writing with the eyes closed we follow still a clear optical outline. In moment A there are two evident factors: (1), constant kinæsthetic memories (*Bilde*) from each position and each amount and direction of movement of the member, and (2) optical presentations of the same positions and movements (*optische intendirte Bewegungsbilde*). Moment C is for Goldschneider entirely kinæsthetic, as we would expect from his earlier papers.¹ He establishes, however, an entirely new element in this kinæsthetic complex in the case of writing, i. e., a series of pressure sensations which vary with each character and each stroke. By a neat apparatus—consisting essentially of an air-cushion, upon which the pen-point of the subject rests, and a connected Marey tambour with graphic attachments—he demonstrates definite pressure curves for the different letters of the alphabet, punctuation marks, etc. [In the view of the present writer, this derivation of "tracery-imitation" is not adequate, simply for the reason that it assumes it. Given "moment" A—an association between definite hand-movements and the corresponding optical presentations of the same hand-movements—the latter might be sufficient, with practice, to innervate the former. But the question remains: How is this association established? How does the child come to connect the optical presentation of figure (*Gestalt*) with the optical hand-movement and kinæsthetic hand-movement series? G. does not recognize the fact that visual recognition of figure (pictures, letters, etc.) is definitely established long before the child is able or has any tendency to trace them.² He is wrong, accordingly, in identifying the optical figure series with the optical hand-movement series. An optical figure-series is really the first "moment" in the derivation of hand-writing—either a purely retinal series or an eye-movement series, according to the view adopted of the rise of visual perception of figure. The question then is: How does this optical figure-series come to stimulate the two muscular

¹See *Untersuchungen über den Muskelsinn*, Du Bois-Reymond's *Archiv*, 1889.

²See my article in *Science*, XIX, 1892, p. 16.

series (kinæsthetic hand-motor and ocular hand-motor)? My observations show that the process is as follows: As the child's experience widens, its optical perception of figures grows exact; certain retinal or eye-movement series grows more and more fixed. At this period the arm and hand-movement series, at first few and fixed, are broken up with the increasing mobility of the member. Consequently, from the arm-movement pictures those elements are emphasized, (1) which are seen as well as felt, and (2) those from the latter which produce results identical with elements in certain definite figure-series already established by the eye. This reproduction of visual figure-elements by movements which are seen establishes gradually the association between the kinæsthetic movement-images and visual figure-outlines; the ocular-movement elements (*optische Vorstellung der Handbewegung*) being, no doubt, an auxiliary, but not a necessary, middle term. In the figure,



X = hand-movement-sensation series (*motorisches Bewegungsbild*), some of whose elements (a, b, c) at once reproduce (graphically) certain elements (a', b', c') in the visual-figure series (Y = *optisches Bild des Gestalt*). Now with the strengthening of this association by practice, appropriate arm (and hand) series follow promptly upon the eye (figure) series which constitutes the "copy." G.'s third "moment" is undoubtedly of great importance, whether or not it be entirely kinæsthetic.

The fact that the first moment is the visual-figure series, and not the visual-movement series, is seen (1) in the fact already cited that figure recognition arises first; (2) that we can trace figures, letters, etc., as G. says, with the foot, head, etc., by movements not usually seen; (3) the memories of the way the hand and pen look in writing are not at all clear compared with the two other elements, i. e., the figure memory of the letters written, and the movement memories. For example, when I think of writing my own autograph, I picture clearly the figured letters which the point of my pen inscribes, and the muscular sensations of the hand, but hardly at all the way the hand looks in the successive stages of the signature; (4) in the analogous case of learning to repeat sound series, there are only two elements, the "copy" series—whether it be auditory (say the gutturals, which children sometimes learn first), visual, or speech-motor—and the resulting sound series (omitting G.'s third moment, the kinæsthetic control series as before); that is, there is nothing corresponding to G.'s optical-hand-movement series (*optische Bewegungsbilde*).]

Investigating, further, the "control" sensations—G.'s third moment—he finds, besides the pressure sensations mentioned above, that angular joint-movement sensations are most important. Beneath the threshold of perceptible joint-movement, pressure sensations still are felt, but pressure points are not distinguished. [This shows that some other control elements (perhaps central quantitative) are necessary for writing, executed by movements beneath the threshold of discrimination by joint sensations. Such writing has been demonstrated by Mohr.] By a further simple apparatus (see fig. p. 516), G. removes the resisting surface under writing movements, and finds that the curves of pressure for different strokes still remain, although the subject is not aware of giving different pressures.

On the pathological side, G. finds two classes of disturbances arising from impairment of the optical element and of the motor element. Under the former he cites left-handed writing, which is sometimes symmetrical with right-hand (*spiegelschrift*—from right to left), and sometimes a reproduction of the copy by the same movement as the right hand (from left to right). The former, "mirror-writing," he thinks is due to the tendency to symmetrical innervation of the two arms when one of them is practiced (*Mitbewegung*). It is possible only in as far as the optical "copy" image is thrown into the background or suppressed. The latter is due to the strength of this optical image in bringing both hands to the reproduction of itself. The motor disturbances of hand writing are also of two kinds, giving "trembling" (*Zitterschrift*) and "tactic" writing. The peripheral cause of the latter is impairment of any of the "control" series, visual, movement (joint), or pressure and resistance sensations. The central causes of disturbance he discusses in another paper (*Berliner klin. Wochenschrift*, 1892).

J. M. B.

Ein deutsches Gelehrtenleben von Prof. Dr. jur. J. E. Kuntze. GUSTAV THEODOR FECHNER. Leipzig, Breitkopf and Härtel, 1892, pp. 372.

The author of this volume is a nephew of Fechner's, and was for many years a member of his household.

Gustav Theodor Fechner was born in 1801 at Grosssärchen, where his father had succeeded his grandfather as pastor of the church. His grandfather had won education and position by persistent struggle with poverty and discouragement, and his memory is still held in honor in the town where he lived as pastor over forty years. His father was remarkable for his independent and progressive spirit, which made him a leader among his people in matters of public utility as well as things spiritual. His mother was the daughter of a pastor, a woman of unusual force and sweetness of character. She was early left a widow in straitened circumstances with five little ones to bring up. The two boys were sent to an uncle, who provided for them for several years. In 1815, Frau Fechner was able to settle in Dresden, and the family was reunited for a short time. In 1817, Fechner entered the University of Leipzig to study medicine. He found most of the lectures he had planned to hear so unsatisfactory that he attended but two or three courses. Indeed, this dissatisfaction, combined with his distrust of the methods practiced in the profession, resulted in his giving it up altogether. He took the regular doctor's degree of the university, but devoted himself more and more to literary pursuits and scientific investigations. Even while studying in Dresden, he had partly met the expenses of his education by giving lessons and translating, and by these means he now earned sufficient for self-support. It was about this time (1820) that he read the first chapter of Oken's *Naturphilosophie*, which, to quote his own words, "so inspired me as to determine the direction of my mind for many years to come." To it he owed his escape from the atheism his medical studies had induced, and the permanent gain of the conception of all nature as a living unity.

In 1824 his mother and sisters joined him in Leipzig, and henceforth his home was with them until his marriage. He continued his translations from French scientific works, with voluminous additions of his own, and wrote besides many original papers on subjects connected with physics. To this period belong also his satires, which he published under the *nom de plume* of Dr. Mises. They are